THE RETURN MIGRATION OF BOGONG MOTHS, *AGROTIS INFUSA* (BOISDUVAL) (LEPIDOPTERA: NOCTUIDAE), FROM THE SNOWY MOUNTAINS, NEW SOUTH WALES

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Abstract

The return (autumnal) migration of *Agrotis infusa* (Boisduval) from the Snowy Mountains commences after most plants have finished flowering, and the return journey to the plains to breed is generally against the general direction of the wind. At the commencement of these flights, bogong moths were recorded flying into the wind, which was a head wind at all altitudes up to 4000 m, and were observed feeding on honeydew.

Introduction

The bogong moth, *Agrotis infusa* (Boisduval), has a mixed biology. In some populations there are spring and autumn generations and no migration. Other populations are univoltine, with adults emerging in spring and migrating up to 1000 km from the western slopes and plains of New South Wales and southern Queensland, to aestivate in rock crevices in the mountains on and adjacent to the Great Dividing Range (Common 1954). The spring migration has been well documented (Common 1954), but post-diapause migrations of insects are generally not as obvious nor as well described as pre-diapause flights, because there are fewer insects involved and the migration flight is thought to be more scattered (Johnson 1969).

During the spring migration, bogong moths have been reported feeding on a number of plants, such as forest and orchard trees, garden flowers and shrubs (McCarthy 1945) and nectar of eucalypt and other flowers (Common 1981). Common (1981) reported bogong moths 'migrating back to their breeding areas, where nectar is again sought before mating' but did not comment on the food used during the actual migration. Moths must make the return migration at a time in autumn when temperatures are low, winds are generally not favourable, most plants have finished flowering, and the moth's body fat is depleted. In these conditions, the food that provides fuel for the return migration is crucial but has not as yet been documented.

Results and discussion

On 10 April 2005, at about 1800 h on an island in Valentines Creek at 1800 m asl, SSE of Mt Jagungal (36°08.5'S, 148°23.2E), I observed fast-flying moths moving unidirectionally northward to where the sky was still light just after sunset; there was no moon. The direction of flight was almost exactly northerly, just off the wind which was from the NNW averaging 8 km/hr and peaking at 14.5 km/hr during observations with a hand-held weather station (Kestrel 3000). The temperature was 14.5°C, in humid conditions leading to a thunderstorm within an hour of the observations.

Looking south, where it was almost dark, and without moving my head, I counted all fast-flying moths passing my vision until 200 had passed. This took 3.5 minutes, which equals 57 moths per minute. The angle of view was small and unquantifiable. Common (1954) used a vertical light beam to count return migration of bogong moths from Mt Gingera and, on 11 April 1952, counted 13-27 per minute at 2-5 m off the ground, which was the approximate height of the flight I observed. Moths were flying fast into a wind that was coming up-valley from the NNW.

There are two distinct ways in which moths migrate. In the first, they may ascend to considerable altitude in rising, warm air and be transported downwind (Drake and Farrow 1988, Gatehouse 1997). In this type of migration the moths cannot feed, have little control over their ultimate destination and may travel great distances in a short time. Alternatively, the moths remain close to the ground (in the boundary layer) and control the direction in which they fly, often having to fly upwind (Johnson 1969). They are able to feed during the migration, may take much longer to travel long distances and may arrive at a definite destination.

Moths migrating close to the ground may be caught in updrafts and taken downwind for great distances, particularly in spring when winds are more violent. Bogong moths trapped like this may reach New Zealand (Common 1981). Captures of moths in northern NSW suggest downwind movement in the geostrophic layer (Gregg *et al.* 1994). In nearly all autumnal records by Common (1954), the wind at ground level was either a cross wind or a head wind, as in the present observations where moths were flying fast into a gentle breeze. There were no favourable winds at higher altitudes. Bureau of Meteorology recordings from Canberra Airport (120 km to the north), throughout the day and into the evening of 10 April 2005, showed consistently NW to N winds at all altitudes up to above 4000 m (15000 feet), moderating from 100 km/hr in the morning to 40 km/hr in the evening (Bureau of Meteorology, pers. comm.).

There has been much research into the assistance that wind gives to migrating insects (Drake and Farrow 1988, Gregg *et al.* 1994), with the implication that bogong moths are just passengers on the wind. However, to be able to locate the same mountain tops for aestivation suggests some control over the direction taken by the moths, as does the ability to migrate back to natal sites against generally unfavourable wind conditions. In these unassisted conditions, autumnal migration would be energetically more expensive, with access to food critical for moths that are returning to breed.

After counting the moths, the shrubs on the island were examined. This revealed thousands of bogong moths, with up to 50 moths on a single shrub. Shrubs containing moths were both epacrids: *Epacris microphylla* s.l. and *E. paludosa*. Other shrubs in the vicinity, *viz. Kunzea muelleri*, *Olearia algida*, *Grevillea australis, Nematolepis (Phebalium) ovatifolium* and the heath *Richea continentis*, had no moths.

Several plants of the two *Epacris* species were examined; only *E. microphylla* that had lerps (Homoptera: Psyllidae) had any moths on them, whereas all *E. paludosa* had lerps and all also had bogong moths. The moths were examined closely by headlamp; all had their proboscides extended and appeared to be feeding. Feeding on the sugary exudate (honeydew) of lerp-forming bugs has been recorded for noctuids (Common 1990), but this is the first record for bogong moths (Ted Edwards pers. comm.). *Epacris paludosa* grew mainly along the rocky banks of Valentines Creek but no moths were observed drinking in the creek.

Light traps set for five years on Point Lookout (1560 m) in northern NSW, about 50 km inland from Coffs Harbour, showed spring numbers of bogong moths (going south) peaking in October or November, with the return migration peak in February/March and a decrease in numbers in April (Gregg *et al.* 1993). The migration recorded in the present study was past the peak recorded by Gregg *et al.* (1993), but the timing was not particularly late.

Although return migration to the natal grounds commences in about March (Common 1954), Green (2003) recorded bogong moths in the mountains, sunning themselves on rocks in May, and bogong moth remains in fox scats in June. Presumably, there is a balance of advantages and disadvantages in the timing of the return migration; the later the migration the greater the chance of autumnal rains and plant growth in the natal sites but also the greater the lack of food for the return journey. The use of honeydew may well alleviate this lack of flowering plants on the return migration.

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